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AN

ESSAY,

ON THE MINERAL PROPERTIES OF THE

Sweet Springs of Virginia,

AND CONJECTURES

RESPECTING THE PROCESSES OF THEIR PRODUCTION BY NATURE,

TOGETHER WITH HINTS

RELATIVE TO AN ARTIFICIAL FORMATION OF SIMILAR

MEDICINAL WATERS.

TO WHICH ARE ADDED,

A FEW CONCISE STRICTURES ON A TREATISE, COMPOSED BY *JOHN ROUCLLE*, M. D. ON THE SAME SUBJECT.

By Doctor **John Baltzell.**
FREDERICK-TOWN, MARYLAND.

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To Doctor **PHILIP THOMAS**, president of the Medical and Chirurgical Faculty of the State of Maryland.

SIR,

The numberless instances of your friendship, unequivocally demonstrated on various occasions, embolden me to present you with the first fruits of my Chemical Lucubrations. Conscious of the difficulties necessarily interwoven with the subject of my Essay, and of my own inability to do it the ample justice it merits ; I beg you to accept of it, as an humble acknowledgment of the many favours, I have received at your hand. A pupillage of four years, under your direction, has enabled me to appreciate your deportment in the various capacities of man and physician, and the distinguished honour which the Medical and Chirurgical Faculty of the State of Maryland have conferred on you, fully evinces the respect and high sense, they entertain for your talents and professional acquirements.

The exalted principles, which have suggested and established the institution, over which you preside, do immortal honour to the Legislature of the State of Maryland, and will insure it to flourish more and more, as humanity and science advance. It must be the most cordial wish of every thinking and benevolent mind, that the care of life and health should be wrested from the hands of empirics and unprincipled pretenders to the healing art, to be reposed in the lap of science and confided alone to those who

are properly qualified by a due course of study in the medical profession. Through the mental imbecillity naturally attendant on disease, how many mortals are deluded by the interested artifices of unfeeling Quackery! How many, duped by artful promises of relief under the writhings of morbid agony, fall victims to medical imposture, and only obtain that relief by an extinction of life! It is the end of your institution, to obviate these evils: it is to such an end your labours are directed: and, give me leave to add, that on so glorious a basis, supported and fostered by the united aid of science and humanity—the superstructure must prove equally useful and beneficial.

As president of this institution you will accept of this Essay, as an unequivocal proof of the high esteem and veneration, I entertain for it and the interest I feel in its prosperity and advancement.

With sentiments of esteem,

Your's affectionately,

JOHN BALTZELL.

Frederick-town, Dec. 22d, 1801.

An Essay, &c.

A CELEBRATED writer on Chemistry says, "The analysis of mineral waters is one of the most "difficult problems of Chemistry. In order to make "a perfect analysis, it is necessary to be aware of "all the distinctive substances, which may be held "in solution in any water. The *operator* must be "acquainted with the means of separating from an "almost insensible residue the different substances, "which compose it: He must be able to appreciate "the nature and quantity of the products, which "are carried off by evaporation, and likewise to "ascertain, whether certain compounds are not "formed by the operations of his analysis, while "others may be decomposed." This account of the qualifications, requisite to accomplish the chemical genius for a complete analysis of the properties of mineral waters, would impel one, more hardy, than I wish to be, to acknowledge his incompentency to such an undertaking; but as commencing this useful work in the State of Maryland, where researches of this nature have been totally neglected, I feel myself animated in the incitement, which this Essay may prove to other votaries of chemical science; who, fully possessed of those qualifications, are completely adequate to the task.

The advantages, resulting from an accurate analysis of medecinal mineral waters, must be clearly evident and forcibly strike every person who bestows a moment's reflection on the subject.

In the firſt place, ſuch an analyſis will prevent the deſtruction of lives, by pointing out the dangerous conſequences of an injudicious use of them.

In the ſecond, by aſcertaining their mineral principles, it will ſerve to improve the method of uſing them and to obviate the errors committed in their uſe ; which, no doubt, have occaſioned them to fail of their effects in many caſes, where they were proper and neceſſary. And thirdly, it will enable us to diſcover a chemical proceſs for an artificial formation of mineral waters of ſimilar properties in due proportions and qualities for the uſe of ſuch valetudinarians, as have it not in their power to travel a diſtance, to obtain the benefit of the natural mineral waters. Theſe are a few among the many conſiderations, that might be adduced to enliſt philanthropy under the banners of chemiſtry.

I do not remember ever having ſeen an account publiſhed of the mineral properties of what are called the Sweet Springs of Virginia. They have excited the curioſity of the public for many reaſons and particularly for their efficacy in relieving the pulmonary conſumption. I have drawn up an account of them together with the method, employed in analyzing them, which I now venture to preſent to the public. Defective as it may be, I hope, it will afford ſome general ideas reſpecting them, and perhaps, animate others, completely converſant in chemical inveſtigations of this nature, to undertake a more correct and minute analyſis of theſe truly excellent medicinal Springs.

The water was conveyed to this place in a bottle well corked, while immerſed in the Springs, and further ſecured with ſealing wax, to prevent the eſ-

cape of the æriform principles: It is very limpid and clear, and to my tongue has an aſtringent ſubacid teſte. Its tranſparency evinces, how perfectly it holds its mineral properties in ſolution: I could not diſcover that it depoſited any ſort of ſediment in the bottle, and obſerved no diſcoloration, by which it might be diſtinguiſhed from common ſpring water. Several wine glaſſes were uſed on the occaſion, in which the experiments were ſeparately conducted and the effects of each TEST were carefully diſtinguiſhed and aſcertained. The reſults were as follow:—

Exp. 1ſt. A few drops of the Muriate of barytes, let fall into ſome of this water, yielded a white cloud: an infallible evidence, that the ſulphuric acid is one of its mineral principles; ſuch is the attraction of the barytes for the ſulphuric acid, that the latter ſeizes the former in whatever combination, it is preſented to it, and forms an inſoluble compound, called Sulphate of barytes or Ponderous Spar.

2d. The pruſſiate of lime, being dropped into ſome of it, afforded the pruſſiate of iron or pruſſian blue, with a quantity of ruſt coloured matter of leſs ſpecific gravity: this indubitably detects the preſence of iron. The pruſſic acid, ſeizing on the iron, produces the pruſſian blue; while the ſulphuric acid of the martial vitrol, ſeizing on the lime, diſengages the iron; which, not finding ſufficient pruſſic acid to unite with, falls down in the ſtate of calx or oxide. I ſuſpect alſo, that ſome of the carbonic acid gas abandons its union with the iron and makes its eſcape in an elaſtic form in this experiment.

3d. A ſolution of carbonate of potaſh, being poured into it, produced a white precipitate. This

ſolution being a teſt, whereby to diſcover as well the combination of magneſia with the ſulphuric acid, as that of alumine or pure clay with the ſame acid; we were determined, by our taſte, to believe it to be the alum. The potaſh ſeizes on the ſulphuric acid, while the carbonate of alumine is precipitated. The magneſia turns the tincture of turnſole of a ſlight green: an evaporation of the water from the precipitate and repeatedly waſhing it with diſtilled water, and after calcining it to diſſipate the carbonic acid, ſubjecting it to the teſt, would aſcertain the preſence of magneſia, if doubts were entertained as to the alumine.

4th. The oxalic acid, dropped into it, yielded a white precipitate, which demonſtrates the preſence of lime, as the acid ſeizes on lime in all combinations forming an inſoluble compound, called the oxalate of lime.

5th. The nitrate of ſilver or ſolution of ſilver in the nitrous acid produced a ſmall luna corneæ, like a white cloud in the water; indicating a ſmall portion of muriatic acid or ſpirit of ſea ſalt united to ſome baſe. In this experiment, the muriatic acid ſeizes the ſilver from the nitrous acid, on account of a ſtronger affinity, forming the luna corneæ; while the nitrous acid attacks its baſe, forming ſome compound perhaps nitrate of ſoda.

The foregoing are the fixed mineral properties; which were detected in the manner, we have deſcribed; two volatile principles, of a diſtinct nature and quality, were alſo diſcoverd to be contained in this water.

Exp. 6th. A few drops of a ſolution of cauſtic lime, being let fall into it, yielded a white precipitate. The lime is ſeized by the carbonic acid gas or fixed air, which appears to be in this water in conſiderable quantity: this precipitate is the carbonate of lime.

7th. By writing on clean white paper, with a ſolution of acetite of lead or ſaccharum ſaturni, and confining it over this water, poured out and agitated in a wineglass, the letters turned of a dark ferruginous hue: ſhewing, beyond the poſſibility of a doubt, that it holds, ſuſpended in it, a quantity of the ſulphurated hydrogene gas:—The hepatic ſmell is an additional proof, if it needed any, of the preſence of this gas in the water.

If any one be diſpoſed to perform experiments with this gas; he may obtain it, by pouring muriatic acid or any other acid or the hepar ſulphuris or liver of ſulphur: by this, the ſolution of ſugar of lead becomes an elegant ſympathetic ink.

8th. The alcohol of galls, poured into this water produced no change: owing probably to my not employing enough of the infuſion or perhaps to the ſuperabundant fixed air in it.

9th. The ſolution of ammoniac or aqua ammoniæ, which is uſed to detect copper, mixed with it, without effecting any alteration in the appearance. We had not a ſufficient quantity of the ſpring water to attempt a further analyſis, by the proceſs of evaporation; in which caſe, the fixed ſaline and earthy principles might have been ſubjected to teſts, applied in different forms.

The accuracy of diſcovering the mineral properties of waters by re-agents; being called in queſtion by ſeveral chemical writers and, this being the only method at preſent in our power, I thought it neceſſary to eſſay this method, by ſyntheſis, in artificial ſolutions of alum and copperas: I accordingly made a ſolution of copperas and of alum, in ſeparate phials, and performed the following experiments with the ſame teſts, which I employed to detect the fixed minerial properties of the ſweet ſpring water.

Exp. 1ſt. I poured a part of the two ſolutions together and, into this mixture, I dropped the pruſiate of lime; when a beautiful pruſſian blue, diffuſed itſelf throughout, without yielding any kind of ruſt coloured precipitate; which circumſtance further confirmed me in my reaſoning on that experiment and in the perſuaſion of the preſence of carbonated iron ore, in the natural mineral waters.

2d. The muriate of barytes, dropped into this mixture, produced a heavy precipitate, the ſulphate of barytes or ponderous ſpar.

3rd. A ſolution of carbonate of potaſh, poured into a ſolution of copperas, precipitated a ferruginous ſediment. but,

4th. being poured into a mixture of the two ſolutions, it yielded a white precipitate, as it does in the water of the Sweet Springs: this, I was poſitive, could be nothing elſe, but the carbonate of alumine.

I have fully ſtated, in the preceding pages, the experiments and my manner of conducting them: as alſo the grounds and reaſons of my concluſions:

I have endeavoured to exhibit a complete view of the proceſſes of my analyſis for the critical inſpection, of ſuch chemiſts, as may be diſpoſed, to examine its merits or improve the method, I employed in conducting it. The ſtriking coincidence of the reſults of my ſynthetical experiments with thoſe performed on the natural mineral waters appears to me a ſtrong demonſtration in favour of my concluſions; according to which, the water of the ſweet ſprings contains the following mineral properties:

	Synon.
Carbonated iron ore.	Calx or oxide of iron, mixed with earthy principles, diſſolved by carbonic acid gas.
Copperas.	Sulphate of iron, martial vitriol, ſupervitriolated iron, ſalmartis, green vitriol.
Alum.	Sulphate of alumine, ſupervitriolated clay.
Fixed air.	Synon. Carbonic acid gas, ærial acid, cretaceous acid, gas ſylveſtre of van helmont, &c. &c.
Sulphated hydrogene gas.	Hepatic gas, ſulphurcaline gas or air, inflammable air holding ſulphur in ſolution diſtinguiſhed by the ſmell of putrified eggs.
Carbonate of lime, and the	Limeſtone, chalk, &c.
Muriatic acid	Spirit of ſea ſalt. Marine acid, &c.

united to ſome earthy or alkaline baſe, perhaps ſoda, in a very ſmall proportion: theſe two laſt, carbonate of lime and the muriate, are alſo found in various quantities in the well waters of Frederick Town and,

I ſuppoſe, bear no part in the medicinal virtues of the ſweet ſprings.

I would not venture to aſſert, that theſe are all the mineral principles, contained in the water of the Sweet Springs: it would require a nice experimental inveſtigation, conducted at the ſpot, and frequently repeated in every modification; before that could be confidently pronounced: I have confeſſed my ignorance of the baſe of the muriatic acid and, in the ſubſequent part of my obſervations, I have conjectured, that there may alſo exiſt a portion of ſulphate of lime or ſelenite in the waters, on grounds which are there ſtated. A quantity of the water, conveyed in a bottle holding about two pounds, muſt have been conſiderably agitated in a journey of upwards of two hundred miles: the æriform principles would naturally riſe in an elaſtic ſtate, ready to eſcape on drawing the cork; and we were ſure, that part of them did eſcape, from the whizzing noiſe produced on giving vent, when it was opened for the purpoſe of experimenting; conſequently, nothing definite could be advanced as to their quantity and proportion in the water, as it is drank at the Spring-head where however theſe as well as the fixed mineral properties muſt always vary, according to the quantity of rain that falls, and the humidity, dryneſs and temperature of the atmoſphere. We did not attempt to aſcertain its ſpecific gravity, which was omitted as a matter of little importance; ſince it could not have been eſteemed accurate, on account of the eſcape of part of the volatile principles: and the temperature of the water muſt be determined by a thermometer immerſed in it at the fountain head.

The temperature and ſpecific gravity of the Sweet Spring water was aſcertained by J. MADISON, Esq. who communicated an account of the experiments in a letter to DR. RITTENHOUSE, which was publiſhed in the 2d vol. of the tranſactions of the American Philoſophical ſociety of which the following is extracted.

Exp. 1ſt. "Having plunged a very ſenſible mer-"curial thermometer in the Spring; it ſtood at 73^0: "the temperature of air was about 69^0.——

2d. "A good hydrometer ſunk one twentieth "of an inch deeper in common mountain water than "in the ſpring."

After the preceding account of the analyſis of the waters of the Sweet Springs; may we not venture into the fields of conjecture and riſque an opinion, reſpecting the origin of their mineral properties. On this diſcovery, muſt depend the imitation of nature by human art and ingenuity. What ſhould prevent the conſequent effects if the cauſes be preſented in equal energy? it is only this, that art requires to rival nature in the production of mineral waters. Such has been the opinion of ſome eminent Chemiſts and, in this inſtance, a knowledge of the formation of the mineral properties of the Sweet Springs, would be incalculably uſeful. Their virtues have been ſo often evinced in relieving the pulmonary conſumption, a diſeaſe extremely frequent in the United States of America. How often does poverty, the debility of the patient and diſtance prohibit the journey!——The conſiderations of the immenſe advantages, redounding from ſuch a diſcovery, may perhaps induce an enlightened Chemiſt

at ſome future period to undertake this arduous and divine taſk, for the glory and welfare of his country.

If I may be indulged in a little ſpeculative reaſoning on the ſubject, I would ſay; that a ſtratum, compoſed of iron ore, ſulphur, alumine or clay and limeſtone; or in other words, that martial pyrites, mixed with clay and limeſtone, would impart to water, as it flowed through it, all the medecinal principles; which we have detected in the Sweet Springs, and advance the opinion; that it is to ſuch a ſtratum, thoſe Springs are indebted for their mineral properties, as it contains in itſelf every material neceſſary for the production of them: although not having ſeen the face of the country nor any foſſils, adjacent to them, I muſt diſpenſe with the beſt aids, to form a correct judgment on that head. However, I hope my preſumption will be pardoned, if, taking for granted, that my conjecture is correct, I endeavour to trace the operations of nature in the production of their mineral properties, agreeably to the principles of modern Chemiſtry.

The preliminary poſitions, which I ſhall here lay down, as a key to unlock the receſſes of this myſtery! have been eſtabliſhed by the experiments of Chemiſts and are generally received as facts and admitted by all new writers on the ſubject, who have adopted the *theory* of *Lavoisier*.

Water is a compound fluid, though formerly conſidered as an element by ſeveral Philoſophers, conſiſting of two principles, oxygene or vital air and hydrogene or Dr. Prieſtley's inflammable air:—— with it, is combined caloric or the matter of heat, in a latent ſtate, and a good deal of atmoſpheric air is

alſo contained in it; but theſe are not component principles of the water; they only occaſion its fluidity * and tranſparency.

The ſulphuric acid is produced, by combining ſulphur or brimſtone with a baſe of vital air or oxygene; in which a diſengagement of heat takes place in a greater or leſs degree :——Conſequently, the ſulphuric acid conſiſt of oxygene and ſulphur combined.

Hydrogene, the other conſtituent part of the water, has the property of diſſolving ſulphur, in which it muſt be conſiderably aſſiſted by the heat, that accompanies the production of the acid.

The ſulphuric acid ſeparates fixed air from limeſtone, wherever it comes in contact with it, by ſeizing on the lime and forming ſulphate of lime, gypſum or ſelenite.

This acid, united to the alumine or pure clay, conſtitutes alum and, united to iron, it compoſes the copperas or martial vitriol.

Now to apply theſe poſitions, as rules of agency in the effects, that would reſult from water coming in contact or flowing through a compoſition of iron.

* Note. Mankind have affixed different appellations to the same substance under different modifications: we say vapour, water, snow, ice, &c. which only vary from each other in adventitious circumstances, depending on the different portions of the matter of heat or caloric and atmospheric air, combined with the same substance. Fluidity may be considered necessary to constitute water; but it nevertheless is only an effect of the causes mentioned. Ice, says Chaptal, is the natural state of water.

ore, ſulphur, limeſtone and clay; we will reaſon thus:

The oxygene of the water, which is decompoſed by the iron and ſulphur, ſeizing on the ſulphur, forms the ſulphuric acid; which has a threefold operation according to the material it meets with, firſt it produces copperas by uniting with the iron, which, being already oxided, is more readily acted upon by the oxygene and ſulphur: ſecondly, by ſeizing on the clay or alumine, it produces alum and, thirdly; by ſeizing on the limeſtone, it ſets at liberty the fixed air or carbonic acid and forms the ſulphate of lime.——Here then we are preſented with the etiology of three principles: the copperas, alum, and fixed air.

Hydrogene, the other component principle of the water, in conſequence of its diſengagement in the formation of the acid with the oxygene, becomes elaſtic and volatile and, probably aſſiſted by the heat, that accompanies the production of the acid, it would naturally diſſolve part of the ſulphur or ſeize it already ſuſpended in the water:——Here then we have the origin of the fourth principle explained: the ſulphurated hydrogene gas.

The preſence of the limeſtone and carbonated iron ore may be eaſily accounted for, by the attrition of the water in its paſſage through thoſe ſubſtances; but the latter, * being previouſly in a ſtate of oxide, is afterwards diſſolved by the ærial acid it meets with in the water, and of courſe, only the muriatic acid, united to ſome unknown baſe, remains unaccounted for.

* Note. Perhaps in part by double elective attraction from the martial vitriol and limestone.

According to this hypotheſis, if ſuch it may be termed, we muſt admit the preſence of another property in the water, for which we had not a teſt, I mean the ſelenite, gypſum or plaſter of paris; for it is preſumable, that if the preceeding are the proceſſes of nature in the production of the properties of the Sweet Springs; a part of the ſubſtance, formed in the diſengagement of the fixed air by the union of the ſulphuric acid with lime, would alſo be diſſolved in it; being ſoluble in five hundred times its weight of water, according to Chaptal at 60^0 of Fahrenheit's.

If ſome future experiment ſhould detect the preſence of ſelenite, gypſum or ſulphate of lime in this water; my conjectures will receive additional probability.

This hypotheſis might eaſily be ſubjected to the teſt of experiment, for which, however, conſiderable reſourſes as well as leiſure; which are wanting to me, would be neceſſary: perhaps ſome one, poſſeſſed of both theſe advantages, may be induced to attempt it hereafter. From the Chemical phænomena, which we may produce, whenever we pleaſe in our laboratories, we have every reaſon to promiſe ourſelves the wiſhed for ſucceſs. Let me inſtance two or three of them: a mixture of iron filings and ſulphur, moiſtened with water, yields the oxid of iron and the ſulphuric acid, by the decompoſition of the water; while at the ſame time, heat, ſufficient to ignite any combuſtible material and hydrogene are diſengaged. The ſame mixture, expoſed to a certain quantity of atmoſpheric air in a large glaſs bell, abſorbs all the oxygene, leaving the azote, ſeptic or nitrogene gas undiminiſhed and,

forming the oxide and acid. If the liver of ſulphur or ſulphurated kali be moiſtened with water, the hydrogene eſcapes with part of the ſulphur in ſolution, forming the ſulphurated hydrogene gas, while the oxygene of the water, uniting with ſome of the ſulphur, compoſes the ſulphuric acid; which uniting with the alkali, produces a neutral ſalt. Theſe experiments demonſtrate the powerful attraction, a mixture of iron and ſulphur have for the oxygene, and further add to the probability of the foregoing hypotheſis.

The experiment could be readily performed, by conſtructing a ſtratum, compoſed of iron ore, ſulphur, limeſtone and clay and conducting a rivulet of freſh and limpid water through it.——To imitate nature in the production of thoſe mineral properties, which we have mentioned, it would be neceſſary to make the ſtratum of ample extent, to confine it, ſo as to prevent the immediate eſcape of the gaſeous principles, that would be evolved and to give the water a ſimilar filtration through it, as it is ſuppoſed to have in its ſubterraneous paſſages, before it reaches the ſpring head.

After ſtating my conjectures, as to the production of artificial bath waters, equal to the natural in their mineral properties; I muſt confeſs, that I am aware of ſeveral difficulties in imitating the proceſſes of nature; which, indeed, appear to me formidable: the manner of conſtructing the ſtrata of mineral and foſſil materials, ſo as to impart to the perfluent water, the preciſe principles, in the ſame quality and proportion, as they exiſt in the Sweet Spring water, is one of the moſt inſuperable of thoſe difficulties: for after the decompoſition of the water

and the formation of the ſulphuric acid by its oxygene; the different ſubſtances, having different affinities to the acid, the prevailing attraction would ſuſpend all the reſt and compoſe but one of the ſulphates, during the preſence of the object of that prevailing attraction. In the table of affinities; the lime has a ſtronger attraction for the ſulphuric acid, than the alumine and this latter would diſplace the iron for the ſame reaſon: it follows of courſe, that if thoſe materials exiſted intimately combined in the ſtratum, through which the water flowed; as long as calcareous earth formed a part of the compoſition, the alum and copperas could not be produced and, after all the lime were ſeized on by the acid, the clay would ſtill prove an impediment to the formation of copperas or the ſulphate of iron.

Nature does not compound her materials into bodies by any laws definitely known: it is evident to us from a view of mineralogy and lithology, that ſhe employs various matrices and mineralizers for the ſame metallic and foſſil ſubſtances: ſhe hardly ever intimately combines them in the ſame modes and proportions; but frequently retains ſome of them, while ſhe diſmiſſes others in the compoſition of the maſs: thus ſeemingly capricious is ſhe in the arrangement of inanimate matter and in this operation ſhe particularly eludes the efforts of art.

It would, therefore, perhaps be more adviſeable to conſtruct diſtinct ſtrata for the production of each different principle, that might be influenced by the action of affinity; than to riſque the production of the mineral properties on a promiſcuous depoſition of the foſſil materials: in this inſtance, it would conſequently be neceſſary to form three dif-

ferent compoſitions: one of iron and ſulphur or martial pyrites: the ſecond of this and alumine or clay, and the third of iron, ſulphur and calcareous ſtones to develope the fixed air: each of which ſhould be intimately compounded: over theſe there ſhould three diſtinct ſtreams of water be conducted properly delayed and percolated, ſo as to afford every advantage and opportunity for a due impregnation of that fluid with the principles, that would be evolved in each ſtratum by its decompoſition. This latter proceſs would alſo put it into the power of the Chemiſt, to diverſify the mineral properties of the water in their qualities and proportions; which might perhaps be eſteemed a conſiderable advantage in the eye of medicine. The waters flowing through the ſeparate ſtrata ſhould be made to deſcend down the ſame ſubterraneous declivity in order to be agitated and mixed together before they reached the general reſervoir, whence they ſhould iſſue into an ample ciſtern for the uſe of valetudinarians. I thought proper to retain the iron ore in each of the compoſitions of the ſtrata, as it is found by experience to promote the decompoſition of water.

After all, that has been ſaid; it muſt be confeſſed, that experiment would alone be the proper guide: for nothing definite can be laid down a priore on ſuch ſubjects, as ſo many incidental circumſtances influence the manipulations of the Chemiſt. The quality of the foſſil matters, the temperature of the weather as well as water, the properties, which the water imbibed from the ſoil, through which it flows, and the ſpace of time it continued in contact with the iron ore, ſulphur, alumine and limeſtone, together with the degree of the confinement of the volatite principles, would conſtitute eſſential points

of conſideration, in the artificial formation of medicinal waters.

The preceding conjectures, reſpecting the ætiology of the mineral properties of the Sweet Springs and, the ſuggeſtions, for a complete imitation of nature in the production of artificial bath waters of ſimilar virtues on an extenſive ſcale, I hope, will not be rejected; before they be thoroughly ſifted and inveſtigated. Some perhaps may precipitantly denounce them as the excentricities of a juvenile brain or the utopia of a ſpeculative theoriſt; but certain I am, that the reaſoning made uſe of on the occaſion is founded on an actual obſervation of Chemical phænomena and, altho' the devotees to phlogiſton would condemn my language, they muſt neceſſarily admit the facts, I have adduced in ſupport of my obſervations.

Nature has ſcattered the greater part of the foſſils, required to put ſuch a plan into operation in vaſt profuſion throughout the United States, and if it ſucceeded, how ineſtimably happy and beneficial would be the conſequences! Every Town or State could be enabled to ſupply their cachectic and conſumptive patients with these ſalubrious waters, at a ſmall expence, through the united aid and contributions of charity and humanity.

Artificial bath waters of the mineral properties, detected in the Sweet Springs, perhaps might be produced, in the ſmall way, by a more expeditious proceſs of the laboratory. Would not a ſolution of alum and copperas, properly proportioned, in a certain quantity of clear and limpid water impregnated with ærial acid, by paſſing through Parker's

apparatus; to which the ſulphurated hydrogene gas ſhould be added by the ingenuity of a practical Chemiſt, conſtitute an artificial mineral water of the ſame medicinal virtues as the natural? To have the advantage of oxide of iron ore, held in ſolution by the water would it not be adviſable to employ for the purpoſe natural chalybeate water or ſuch made artificially? Theſe queries can beſt be anſwered by experiment.

However before this plan could be ſucceſsfully executed, it would be neceſſary to aſcertain the proportions of the ſubſtances to be diſſolved by a nice calculation of them in a given volume of Sweet Spring water; it would alſo perhaps be neceſſary to find out; whether it would be more expedient to introduce the carbonic acid and hepatic gaſes at the ſame time, or ſeperately in ſucceſſion; and with which it would be moſt proper to impregnate the ſolution. * If all theſe points were well determined by repeated experiment, we then might pretend to rival nature even in our laboratories, for which this proceſs is well adapted; while the other predicated from a plan, eſtabliſhed on the original formation of the mineral properties by nature and on a more extenſive ſcale of utility, would require for its execution, the munificence of a ſtate or city.

Since nothing certain can be pronounced, reſpecting the reſults of any chemical operations; be-

* Note. These gases may be introduced into the water at the same time by mixing chalk and liver of sulphur in Parker's apparatus and pouring diluted sulphuric acid or vitriol over the mixture: but in this manner, their proportions cannot be managed: they may be produced seperately from these substances by means of the acid in which case they can be introduced in any proportions.

fore they are repeatedly ſubjected to the teſt of experiment, which muſt finally determine the merits of all our ſpeculations on this ſubject I feel great diffidence in preſenting this eſſay to the public.—— I do not pretend to perfection in my performance and, from the intricacy of chemical affinities, which conſtitutes the ſublimeſt part of hermetic ſcience, it is poſſible that fallacies may have crept into the deductions, I have made on the ſubject of my analytical reſearch : however I am not aware of any and, if ſuch be diſcovered by an ingenious critic, I ſhall gratefully acknowledge the favour.——With reverence and awe, I approach the fane of ſcience, fearful, whether I be a welcome votary : my offering, I preſent on the altar and await my ſentence, in patient ſilence.

Poſtſcript.

SINCE writing the preceeding account of the Chemical analyſis of the mineral properties of the Sweet Springs, I have met with a treatiſe, compoſed on the ſame ſubject by John Rouelle, M. D. from Europe, which was publiſhed in the year 1792, at Philadelphia. I have given it a repeated diligent peruſal and find that, not totally liberated from the embarraſſments of phlogiſtic Chemiſtry, he had to combat an unconquerable obſcurity in the explication of his Chemical experiments. He teſted all the noted medicinal Springs of Virginia : his analyſis of the Sweet Springs appears to me the moſt unſatisfactory in his whole treatiſe, as it affords not

the moſt diſtant inference for an artificia. production of the mineral properties of thoſe waters. His account differs in a great meaſure from that drawn up in the foregoing pages: I have therefore taken the liberty of examining it, on the principles of pneumatic Chemiſtry.

Doctor Rouelle's attempts in the liquid way for detecting the mineral properties of the Sweet Springs are very imperfect and ſuperficial: he employed ſeven teſts and for their Chemical reſults, he does not even venture an explanation; however as he laid little or no ſtreſs on the method of analyſis by re-agents, depending chiefly on evaporation of the water for the diſcovery of its fixed mineral properties: it is the latter I conſider the principal ſubject of attention.

Doctor Rouelle began his proceſſes, by evaporating twenty two quarts of the Sweet Spring water in the balneum maris or hot water bath, when there firſt appeared on the ſurface a "thick pellicle" after the eſcape of a gas, which he aſcertained to be the ærial acid, of which very little more was diſengaged; after the formation of the pellicle: this broke and ſubſided to the bottom.

A ſimilar phænomenon takes place, if a ſolution of cauſtic lime be expoſed to the atmoſpheric air, by attracting the carbonic acid, afloat in it, and forming carbonate of lime: the oppoſite of this happens in the formation of the pellicle by the evaporation of the water; for the acid, inſtead of being attracted, flies off.——it is thus accounted for: although the cauſtic lime has a powerful affinity to the fixed air; yet it can retain, but a certain portion

in union with it and whatever is beyond this point of ſaturation, will eſcape. The fixed air aids the water in the ſolution of the lime and, as ſoon as this abandons it, the water is left alone to act on the ſolubility of the carbonate of lime (and probably other earthy ſubſtances, &c. with it) of which, conſequently, the undeſolved portion is precipitated.

When the quantity was evaporated to a quart; a yellowiſh colour appeared:——This, he thinks, is probably owing to the iron, contained in the water. I am of opinion, agreeably to my experiments, that it is partly owing to the cerbonated iron ore and, in part to the copperas: the water ſtill retains an acidulous taſte, which, he ſuppoſes, is owing to a "portion of ærial acid in a true combination with "iron and a little earth. This is the reaſon, why "it appears a little turbid and whitiſh." I cannot admit, that this acid taſte was occaſioned by the carbonate of iron, as he thinks: is it not evident, how readily the fixed air abandons the iron, from the ochreous depoſitions of acidulous chalybeate waters, and is it preſumable, that the iron would retain it in ſuch a ſuperſaturated ſtate, as to yield an acid taſte after an evaporation of twentytwo quarts to one quart, in boiling water? * The part falling to the bottom and ſticking hard to the glaſs veſſel, ſome experiments proved to him "to be rather the calcareous mephite and a very little ſelenite."

When the evaporation was carried to a ſufficient point, he took the whole reſiduum and put it into a bottle, to take along with him, to try more

* Note. When the evaporation was continued he says "it went off entirely," but what was its taste then? was it aſtringent?

experiments at home: when he opened it, he ſays, "it ſmelled a good deal of rotten eggs, ſtronger "than it was at the ſprings: and a bottle of the "Spring water had hardly any ſmell, but was aci-"dulous." This hepatic odour, undubetably proves the preſence of the ſulphurated hydrogene gas; but he feels great uncertainty on the ſubject and obſerves: "However *I* would not perſuade *myself* "*that there* is no hepatic air becauſe ſulphur is to be "found there in plenty enough, to give ſuſpicions "of it. But theſe particulars belong more to other "reſearches." Modern Chymiſtry readily unfolds the enigma, by tracing the origin of this gas, to the decompoſition of water and the ſolution of ſulphur in the hydrogene.

He now evaporated this to dryneſs and rediſſolved the reſiduous ſubſtances in diſtilled water.—On a new evaporation to a degree of chryſtallization, the ſolution "was of a brown colour, making no "kind of efferveſcence with acid or alkali and form-"ing no precipitate, which were proofs, that the "ſalts were perfectly neutralized." It is to be lamented, that he had not an opportunity of obſerving the reſults of muriated barytes, pruſſiate of lime or carbonate of potaſh, employed as teſts in this ſolution; which would have thrown great light on its contents.

This ſolution was now evaporated to dryneſs "the chryſtallizable ſalts apart—if we add an acid, "there is an efferveſcence and ſomething remains "untouched; with the vitriolic acid, there is a ſo-"lution of calcareous earth and what remains, is a "little of vitriolated tartar and ſiliceous earth." The efferveſcence is, undoubtedly, occaſioned by

the eſcape of a gas. What are his proofs for the vitriolated tartar? is it produced by the acid employed in teſting? "ſomething remains untouched" is this the ſiliceous earth or the ſulphates of iron and alumine? for these alike elude the action of the acid.

"The chryſtals obtained" he further ſays "are "evidently epſom ſalt or vitriol of magneſia and "ſome chryſtals of a marine ſalt," this laſt I admit as proved by the luna cornea, formed by the nitrate of ſilver: the other, I cannot admit as the figure of the chryſtals are here of no avail to determine its preſence: he alſo ſays "I followed the way of diſ- "tilled vinegar to diſſolve the calcareous earth and "make a foliated earth, &c. the liquor, being eva- "porated afterwards, gave no chryſtals and is "thick:——Then on precipitating it, it is found "to be magnesia, which was in the water in perfect "combination with ærial acid." Here we obſerve, he aſſerts the preſence of magneſia without offering any evidence for it. Elleot on bath waters, when ſpeaking of the analyſis of mineral waters by evaporation, remarks; "the baſis of ſalts, compounded of the "vitriolic acid, may be diſtinguiſhed by the figure "of the chryſtals; except natron and *magnesia*; "but the latter" he adds "renders lime water tur- "bid: the former does not." The Doctor has advanced conjecture alone for the preſence of magneſia and, if we are allowed to judge, by the proceſſes, he has recited, employed no experiment to aſcertain, that the water contains it, as he ſays "in perfect combination with the ærial acid:" it is therefore, in my humble opinion, an inference grounded on mere ſuppoſition.

After this ſuccinct view of Doctor Rouelle's analyſis of the Sweet Springs, I am inclined to think it defective and unſatisfactory, deſtitute of the philoſophical preciſion, which ought to characterize reſearches of that nature——of this, he himſelf appears to have been fully conſcious; when he concludes by ſaying: "hence it follows that the aci-"dulous ſpring in Bath County (meaning the Sweet "Spring) contains in the quart:

Of Saline ſubſtances in general	12 to 15 gr.
Earthy ſubſtances	18 to 24
Iron	1 to ½

thus noting down the fixed mineral properties in the undefined generical terms of ſaline and earthy ſubſtances and iron, which cannot afford the moſt diſtant hint for the artificial formation of ſimilar medicinal waters. Although from the account of the Doctor's analyſis, it does not appear, that he even ſurmiſed the preſence of alum and copperas in the Sweet Spring water; yet none of his experiments tend to refute or invalidate my inferences from the reſults of my chemical teſts: the obſervation, cited before reſpecting the turbid and whitiſh aſpect of the water after conſiderable evaporation, ſuggeſts to my mind a ſuſpicion, that it was occaſioned by thoſe two ſubſtances and, he alſo ſays: on opening the bottle, that contained the reſiduum, left from the firſt evaporation, it was quite black; "the end of the cork "of the ſame colour, and covered with ſmall chryſ-"tals:" he does not inform us, what theſe chryſtals were.——To aſcertain what effect a ſolution of copperas would have on a cork; I laid one in a ſolution of it for ſome hours, when it turned black in like manner: the acid itſelf has a ſimilar effect, as

may be ſeen in phials containing it, being injudiciouſly ſtopped with corks.

His remarks on the foſſils of the mountain, whence the ſpring iſſues; prove a ſtrong ſupport to the opinions, I have ventured to maintain in the preceding eſſay, relative to the etiology of the mineral properties of the Sweet Springs. He obſerves "each ſide of the mountain is covered by free ſtone, "ſome other parts are a kind of jaſper variegated "with white lines, and the baſis of the whole moun-"tain is a hard earth, compoſed in general of clay "and limeſtone, in different proportions, mixt with "iron and coloured by it," and probably an actual examination would diſcover the ſulphur in ſubterraneous ſtrata intermixed with theſe ſubſtances: which in my opinion, would evolve and impart to perfluent water the mineral properties, diſcovered in the Sweet Spring water, by our chemical teſts. Agreeably to his analyſis, the Doctor admits the preſence of ſelenite or gypſum in it, which I had conjectured a priore in purſuance of my hypothetical reaſoning on the ſubject of the original principles of its production, before I ſaw this treatiſe: he alſo admits that the "ſulphur, ſpread in pyrites as well as in "rotten wood, is conſtantly operating new compo-"ſitions and decompoſitions, with all the ſubſtances it has attraction to."

To have my theoretical conjectures ſo well ſupported and corroborated with facts by Doctor Rouelle, a Chemiſt of no common fame, who was on the ſpot and viewed the face of the country and examined its foſſils with judicious attention, free from ſpeculative prepoſſeſſions; affords a powerful additional proof, that my Hypotheſis, reſpecting the natural origin

of the mineral properties of the Sweet Springs and ſuggeſtions for the formation of ſimilar medicinal water by artificial means, merit at leaſt a candid inveſtigation; before they can be authoritatively denounced as chimerical.

FINIS.